

REMARKS

All the claims submitted for examination in this application have been rejected on two substantive grounds. Applicants have considered these grounds of rejection and respectfully submit that the amended claims currently in this application are patentable thereover.

The first substantive ground of rejection is the rejection of all the claims currently in this application, Claims 1, 3-7, 9-13 and 18. Claims 1, 3-7, 9-13 and 18 stand rejected, under 35 U.S.C. §103(a), as being unpatentable over U.S. Patent Application Publication No. US 2002/0052125 to Shaffer et al. taken in view of U.S. Patent No. 6,121,130 to Chua et al. and U.S. Patent No. 5,908,510 to McCullough et al.

The Official Action avers that Shaffer et al. discloses a process of forming an etched, coated semiconductor device followed by removing impurities that includes disposing a low dielectric constant curable organic polymeric film on a electrically conductive surface of a semiconductor substrate. The film layer or layers is cured followed by a heating step to remove impurities from the film. The low dielectric constant curable organic polymeric film may be a polyarylene resin or a polysilsequioxane.

The Official Action concedes, in this discussion of the teaching of Shaffer et al., that Shaffer et al. does not disclose the critical step of contacting the low dielectric constant curable polymeric film with supercritical carbon dioxide.

The secondary Chua et al. patent is applied for its teaching of removing both residual solvent and polymeric byproducts from a semiconductor substrate coated with a

film by thermal steps. As such, the secondary Chua et al. reference is applied for its important teaching that the impurities removed from the cured organic polymeric film are residual solvent and polymeric byproducts. Insofar as it utilizes thermal steps to provide this removal, it, like Shaffer et al. does not address the invention defined by the claims of the present application.

The tertiary McCullough et al. disclosure is applied for its teaching of using supercritical carbon dioxide to remove residue from surfaces. However, that removal is not directed to the removal of materials present on a cured low dielectric constant or organic film which comprises a polyarylene resin. Attention is directed to Column 2, lines 50-54, which citation is included at Page 3 of the outstanding Official Action.

Thereat, the Official Action argues that McCullough et al. teaches the removal of residue from surfaces, especially top surfaces of semiconductor devices. McCullough et al. states that the removal of residue from such surfaces refers to that residue formed by subjecting the precision surface to a material removal process, such as chemical etching, ion etching or laser ablation, as part of a process of creating or modifying the precision surface. The residue formed may be removed from etched surfaces or adjacent non-etched surfaces. It is clear that removal of materials of the type taught in Chua et al., e.g. residual solvent and polymerization by-products, are outside the contemplation of McCullough et al.

That the semiconductor sample maybe a pattern film structure, such as a polyimide, as set forth at Column 5, lines 43-55, is irrelevant. These surfaces, which may be any one of a multiplicity of other materials, must, based on the teaching of McCullough et al., be subject to an etching technique, such as reaction ion etching.

No such teaching is provided in the claims of the present application. The clear teaching of the claims of the present application is to remove impurities inherent in the cured polyarylene resin or poly(silsequioxane) film.

The above remarks emphasize that the claims of the present application are directed to processing steps in the formation of a cured low dielectric constant polymeric film disposed on a semiconductor device. Such is the subject matter of the primary Shaffer et al. and secondary Chua et al. patents. These patents are devoid of any suggestion of utilizing supercritical carbon dioxide to remove impurities therefrom.

The only disclosure of utilizing supercritical carbon dioxide is the tertiary McCullough et al. reference which has nothing at all to do with removal of impurities inherent in the formation of a cured organic polymeric film layer. The outstanding Official Action teaches a process of removing impurities from a cured low dielectric constant organic polymeric film formed in a totally different processing operation. One skilled in the art of removing byproducts formed in a chemical reaction would not look to a process of removing solids from a solid surface, as taught by McCullough et al. Stated differently, the process of the present application, although not involving a chemical reaction per se, is a chemical processing step, rather than a solids removal step.

The Official Action appreciates this distinction and attempts to interpret the applied references in a manner ill suited to their teaching. That is, the outstanding Official Action attempts to suggest that the removal of impurities from a precision surface include polyimides. To that end the Official Action again relies on McCullough et al. at Column 5, lines 43-55. That portion of the specification, as suggested above, supports applicants' position rather than the position argued in the Official Action. A

polyimide is recited therein as being included in the semiconductor sample. It is emphasized that there is nothing in Shaffer et al. or Chua et al., the two references directed to the formation of polyarylene resin or polysilsequioxane films, in which the distinguished methods employed in those references for removal of impurities, heating or rinsing with water, that relates to the teaching of the tertiary McCullough et al. reference.

It is emphasized that the above remarks establish that a prima facie case of obviousness is not created by the combined teaching of Shaffer et al., Chua et al. and McCullough et al. However, as indicated previously, the showings provided in the examples of the specification rebut any presumption of obviousness that might have been created by the applied teaching of these references.

Attention is directed to the results of the comparison between Example 1 and Comparative Example 1. As depicted in the Figure, the mean refractive index of the cured Silk® untreated with supercritical carbon dioxide was initially lower than the mean refractive index of the cured Silk® treated with supercritical carbon dioxide. Almost immediately after treatment the mean refractive index of the cured Silk® untreated with supercritical carbon dioxide rose above that of the cured Silk® contacted with supercritical carbon dioxide. This higher level of untreated cured Silk® continued over the duration of the test reaching an asymptotically higher level after the three weeks.

Although the Official Action discounts this improvement, those skilled in the art appreciate that the higher refractive index of the untreated cured Silk® film layer is evidence of the inclusion of undesired byproducts, solvents and uncured monomers. The removal of such products are clearly outside the teaching of McCullough et al. and is not suggested by either of the Shaffer et al. and Chua et al. references. Insofar as dielectric

constant is correlatable to mean refractive index, this allegedly small increase in mean refractive index or decrease in dielectric constant is critical to the effectiveness of a semiconductor which is coated with a cured polyarylene resin, e.g. Silk®, and evidences the unexpected result obtained by the practice of the process of the present application over the prior art.

Additional data is provided in the specification of the present application to further emphasize the unexpectedly improved results obtained by the utilization of the claimed process of the present application over the applied references. This data, based on thermal desorption mass spectrometry (TDMS), establishes that treatment with supercritical carbon dioxide provides a totally unexpected result not obtainable by the teaching of the applied references. When treatment with supercritical carbon dioxide of a polyarylene or polysilsequioxane film layer is conducted, undesirable aromatic byproducts, generated from the polyarylene or polysilsequioxane polymer, are removed.

Nothing in McCullough et al. suggests this result. The teaching of McCullough et al. is directed to removal of debris formed during ion etching, long after any polymeric film is disposed on a semiconductor wafer subject to ion etching. It is thus apparent that this showing rebuts any presumption of obviousness created by the applied references. Reconsideration and removal of this ground of rejection is therefore deemed appropriate.

The second substantive ground of rejection is directed to Claims 1, 3-7, 9-13 and 18. These claims stand rejected, under 35 U.S.C. §103(a), as being unpatentable over McCullough et al. taken in view of Shaffer et al.

It is unnecessary to discuss this ground of rejection insofar as it is substantially identical to the first ground of rejection. Suffice it to say, the failure of the critical

tertiary McCullough et al. reference to utilize supercritical carbon dioxide as a means of removing impurities formed in the chemical reaction of curing an arylene or a silsequioxane monomer emphasizes the patentable nature of the claims of the present application.

The above remarks apply to the third substantive ground of rejection, the rejection of Claims 14-17, under 35 U.S.C. §103(a), as being unpatentable over Shaffer et al. taken in view of Chua et al. and McCullough et al. in further view of U.S. Patent No. 6,558,475 to Jur et al.

It is unnecessary to discuss the teaching of Jur et al. applied for its teaching of cleaning a workpiece with supercritical carbon dioxide and an additional co-solvent. This is so insofar as there is nothing in the Jur et al. disclosure that suggests the removal of impurities formed in the curing of an arylene or a silsequioxane monomer to provide a polymeric film in which impurities are removed by the formation of a polymer.

Similarly, the fourth ground of rejection, the rejection directed to Claims 14-17 as being unpatentable, under 35 U.S.C. §103(a), over McCullough et al. in view of Shaffer et al. and in further view of Jur et al., is unavailing.

Applicants do not rely on the addition of a co-solvent, in combination with supercritical carbon dioxide, for patentability of the claims in the current application. Suffice it to say, the combined teaching of McCullough et al, Shaffer et al. and Jur et al. does not present a prima facie case of obviousness. Even if that teaching presented a prima facie case, which is not the case, the showing presented in the specification of the present application, rebuts any presumption of obviousness created by that combined teaching.

To further emphasize the patentability of the claims of the present application, those claims have been amended to emphasize the impurities removed from the low dielectric constant organic polymeric film of the present application. That is, the claims of the present application have been amended to indicate that the impurities removed from the present application are residual solvents, unreacted monomers and byproducts of curing from dielectric films disposed on semiconductor devices. As stated above, it is this distinction which clearly distinguishes the claims of the present application from the combined teaching of the applied references.

It is noted that an amendment to Claim 18 corrects a typographical error wherein the claim is provided with proper antecedent basis. This amendment to Claim 18 merely eliminates a typographical error where the plural of silsequioxanes is recited and the further typographical error of omitting the word "film" is corrected.

The above amendment and remarks establish the patentable nature of all the claims currently in this application. Notice of Allowance and passage to issue these claims, Claims 1, 3-7 and 9-18, is respectfully solicited.

Respectfully submitted,



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